Radio Science Support

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Since 1967, radio scientists have used the DSN 26- and 64-m antenna stations to investigate pulsars, the effects of the solar corona on radio signals, to observe radio emissions of X-ray sources, and have used very long baseline interferometry techniques for high-resolution studies of quasars. The various experiments are identified and summarized, and the published results are indicated.

I. Introduction

The 26- and 64-m antenna stations of the DSN have been used for several years to support radio science experiments (Ref. 1). NASA, JPL, and university scientists have used key DSN facilities whose particular and unique capabilities were required for the performance of the experiments. In order to formalize the method of selecting experiments and experimenters, a Radio Astronomy Experiment Selection (RAES) Panel was formed in 1969 (Ref. 2). Notice of the availability of these facilities was placed in professional journals to inform the scientific community that they were available for limited use by qualified radio scientists. No charge is made for use of the standard DSN facilities and equipment; special equipment, however, must be provided by the experimenters (Ref. 3). A number of experiments have since been proposed, evaluated, selected and performed (Refs. 4, 5 and 6). A summary of the experiments conducted, both before and since formation of the panel, is shown in Table 1.

II. Radio Science Operations

Activities through October 31, 1970, have been reported in Refs. 1 through 6. The scientific results of these experiments that have been published in the open literature are shown in Refs. 7 through 20.

The character of the experiments being conducted indicates the unique DSN capabilities being employed. The very long baseline interferometry (VLBI) experiments depend upon the widely separated stations to achieve high angular resolution. The X-band VLBI and the earth physics VLBI at S-band depend in addition on the extreme stability provided by hydrogen maser frequency standards. The X-band pulsar measurements are made possible by the very low system noise temperature and high

sensitivity of the 64-m antenna station. Both the stability and sensitivity are necessary to conduct the general relativity experiment by VLBI techniques.

As indicated in Refs. 15, and 17 through 20, the extremely high angular resolution of the VLBI technique (milliseconds of arc) along with high sensitivity, gives the DSN a unique capability which has been used to resolve the fine structure of quasars. This data has provided fresh material for discussions of the character and origin of these sources (Ref. 20).

III. RAES Panel Activities

A summary of recently approved experiments is shown in Table 2.

References

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Table 1. Radio science experiments involving 64- and 26-meter antenna facilities

Experiment	Purpose	Experimenter	DSN facility	Date	Published findings
Pulsar measurements (2295 MHz)	To study pulse characteristics	A. Moffet (Caltech) R. D. Ekers (Caltech)	DSS 14	May 1967 April 1967 May 1967 March 1969	Ref. 7 Ref. 8 Ref. 9
Lunar occultation of radio sources (2295 MHz)	To determine intensity and angular size of radio sources	A. Maxwell (Harvard) J. H. Taylor (Harvard)	DSS 14 DSS 11	July 1967 Oct. 1967 Jan. 1968 April 1968	Ref. 10
Very long baseline interferometer (narrow data bandwidth, S-band)	To determine angular size of radio sources using trans-Pacific baseline	J. Gubbay (Univ. of Adelaide) A. Legg (Space Research Group, WRE) D. Robertson (Space Research Group, WRE) A. Moffet (Caltech) B. Seidel (JPL)	DSS 14 DSS 11 DSS 12 DSS 41 DSS 42	Sept. 1967 Nov. 1967 May 1968 June 1969	Ref. 11 Ref. 12
Study characteristics of radio source signals after passage through solar corona (2295 MHz)	To determine angular size of radio sources	R. Ekers (Caltech)	DSS 11	Oct. 1967	
Planetary radiometric observations	Continuing survey	S. Gulkis (JPL) D. Jones (JPL) B. Gary (JPL)	9-meter antenna at DSS 13	Continuing from 1967	Ref. 13
Jupiter occultation of radio sources (2295 MHz)	To investigate structure of Jupiter magnetosphere	B. Gary (JPL) D. Nicolson (South African Scientific Institute for Research)	DSS 51	Sept. 1968	
X-band pulsar	To study X-band emission of pulsar	A. Moffet (Caltech)	DSS 14	July 1970	
General relativity VLBI (X-band)	To test the theory of general relativity using VLBI techniques to observe 3C273 and 3C279 near solar occultation of the latter	B. Burke (MIT) T. Clark (GSFC) R. Goldstein (JPL) A. Rogers (Haystack Radio Observatory) I. Shapiro (MIT)	DSS 14 (and MIT Haystack antenna)	Oct. 1970 Feb. 1971	Ref. 19 Ref. 20
Pulsar polarization measurements	To study polarization characteristics of five pulsating radio sources at 2295 MHz	A. Moffet (Caltech) R. D. Ekers (Caltech)	DSS 14	Oct. 1970 April 1971	
Indian Ocean VLBI (narrow data bandwidth, 2295 MHz)	To observe southern hemisphere radio sources	D. Robertson (Space Research Group, WRE) G. Nicholson (SA-CSIR)	DSS 41 DSS 51	Nov. 1970	Ref. 17
Very long baseline interferometry (2295 MHz, NRAO recording terminals)	High resolution studies of extra galactic radio sources	J. Broderick (NRAO) B. Clark (NRAO) M. Cohen (Caltech) D. Jauncey (Cornell) K. Kellermann (NRAO)	DSS 13 (and NRAO 140-ft antenna)	Nov. 1970	
Earth physics VLBI (S-band)	To demonstrate feasibility of DSN-VLBI for geophysical applications	P. MacDoran (JPL)	DSS 12 DSS 14	Jan. 1971	
X-band VLBI	To study structure of extra galactic sources with improved resolution	K. Kellermann (NRAO) M. Cohen (Caltech) B. Clark (NRAO) D. Jauncey (Cornell)	DSS 14 (and MIT Haystack antenna)	Feb. 1971	

Table 1 (contd)

Experiment	Purpose	Experimenter	DSN facility	Date	Published findings
Jupiter radiation belt study	To measure intensity of beamed radiation and its variation with Jupiter rotation	S. Gulkis (JPL)	DSS 14	March 1971	
Solar scintillation (2295 MHz)	To determine solar wind characteristics	R. Ekers (Caltech) L. Little (Caltech)	DSS 14 DSS 11 DSS 12 DSS 13	April 1969	
Jupiter polarization experiment (2295 MHz)	Circular polarization measurements of Jupiter at 13 cm	B. Gary (JPL) S. Gulkis (JPL)	DSS 14	April 1969 May 1969	Ref. 14
Very long baseline interferometer (NRAO wideband terminal, S-band)	To determine angular size of radio sources using trans-Pacific baseline and wideband system	M. Cohen (Caltech) A. Moffet (Caltech) D. Shaffer (Caltech) B. Clark (NRAO) K. Kellermann (NRAO) D. Jauncey (Cornell) S. Gulkis (JPL)	DSS 14 DSS 42	June 1969	Ref. 15
General relativity interferometer experiment	To measure apparent change in angular separation of two radio sources when one is occulted by sun	D. Muhlemann (Caltech) R. Ekers (Caltech) E. Fomalont (Caltech)	DSS 14 DSS 13	Oct. 1969	Ref. 16
Very long baseline interferometer (medium data bandwidth, S-band)	To determine angular size of radio sources	J. Gubbay (Univ. of Adelaide) A. Legg (Space Research Group, WRE) D. Robertson (Space Research Group, WRE) A. Moffet (Caltech) B. Seidel (JPL)	DSS 14 DSS 11 DSS 42	Dec. 1969 June 1970 Jan. 1971	Ref. 17
SCO-XR-1 Observations	To observe variability of 13 cm radio emissions and their correlation with observed optical variability	M. Lampton (UC-Berkeley) S. Boyer (UC-Berkeley) J. Welch (UC-Berkeley) G. Grasdalen (UC-Berkeley)	DSS 14	June 1970	Ref. 18

Table 2. Recently approved experiments

Experimenter	Objective	Comments
H. S. Zisk (MIT, Lincoln Laboratory) C. A. Knight M. A. Slade (MIT, Department of Earth and Planetary Sciences)	Precision VLBI Observations of *Apollo* ALSEP Transmitter	Approved 19 November 1970; support plans in process
J. Broderick (NRAO) B. Clark (NRAO) M. Cohen (Caltech) D. Jauncey (Cornell) K. Kellermann (NRAO) L. Matveenko (Institute for Cosmic Research, USSR) I. Moiseyev (Crimean Astrophysical Observatory, USSR) V. Vitkevitch (Institute for Cosmic Research, USSR)	High Resolution Studies of Extra Galactic Sources at 3 cm by VLBI	Scheduled for May and June 1971